

REINFORCED  
CONCRETE RAILWAY TRESTLE

BY  
T. F. WOLFE

ARMOUR INSTITUTE OF TECHNOLOGY

1912

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Design of a standard  
reinforced concrete railway

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THESIS  
—  
DESIGN OF A STANDARD  
REINFORCED CONCRETE  
RAILWAY TRESTLE .

Presented by

*Thomas F. Wall*

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to the  
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Approved:

*Alfred E. Phelps.*  
*Prof Civil Engineering*  
*H. M. Raymond*  
*Dean of Eng. Studies*  
*L. C. Morrin.*  
*Dean of Cult. Studies.*





DESIGN OF A STANDARD  
REINFORCED CONCRETE  
RAILWAY TRESTLE.

PREPARED AS A  
GRADUATION THESIS

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BY \_\_\_\_\_  
\_\_\_\_\_

THOMAS F. MOFFE  
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CHICAGO, ILL.

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## THE DESIGN OF A STANDARD REINFORCED CONCRETE RAILWAY TRESTLE

In railway construction numerous places are encountered where fills are prohibitive because of the nature of the ground, and where long span bridges would be too expensive to use. This is true of boggy land, swamps, river bottoms, and such places where there is no flow of water to speak of, but where fills would be undesirable. In these locations, since there is neither floating ice nor drifting material to look out for, there is no objection to the large number of supports necessary in trestles. For these reasons trestles have been used since the earliest days of railroad construction. Up to a comparatively few years ago wood was used exclusively for this class of structure, but it is now being replaced by steel and concrete.

For extremely high structures steel is used, while for all other structures concrete is most adaptable. The general design of the concrete structure follows closely the general lines of the old wooden one. Spans of from fifteen to twenty feet are used, supported either on piers, or on pile bents. The pile bents used, are practically a duplicate of the wooden ones, but are entirely of reinforced concrete; they are used where the height of the structure is not so great as to cause excessive bending in the supports. In cases where bending does take place thin piers are substitut-



ed for the pile bents. The use of the thin piers makes it more economical to use larger spans than are used with pile bents, so in the following work a twenty-two foot slab has been designed for this type. The great advantage of the pile bent type is the fact that it reduces the field work to a minimum, since both the slabs and piles are cast at some central yard, leaving only the pile caps to be cast at the bridge site. In the following work the complete figures are shown for the design of each part of the trestle as well as the drawings of each part and of the entire structure. The last plate shows in detail the material necessary for the various parts of the trestle.





## DATA

LOADING:-Live load--Coopers L 50

Dead load--Weight of slab, ballast, and track.

Concrete=150# per cu. Ft.

Ballast =100# " " "

Track =150# " lineal Ft.

Timber = 4 1/2# " board Ft.

SPECIFICATIONS:-American Railway Engineering and Maintenance  
of Way Association.

SPANS:- 15, 16, 17 and 22 Feet.

Considering a depth of 6" of ballast under the tie and a tie 8x10x10-0, the dead weight per foot of bridge is as follows:

Wt. of 1 tie	= 300#
" " 8 cu. Ft. of ballast	= 800#
" " 1 Ft. of track	= <u>150#</u>
Total wt. per ft.	=1250#

Since the width of slab is 14'-0" the dead load per sq. ft.  
of bridge=1250 ÷ 14 =90

## STRESSES IN SLABS

A.-15 ft. Span:- Live load bending moment per rail=1,878,000  
inch pounds.

This moment is distributed over 7 feet of slab, therefore  
the bending moment taken by 1 foot= $\frac{1,878,000}{7}$ =268,300 in. lbs.  
Assume weight of slab to be 300 lbs. per sq. Ft.

Dead load bending moment= $\frac{390 \times 15^2 \times 12}{8}$  =131,800 in. lbs.



$$\text{Impact} = 268,300 \frac{300}{300+15} = 256,000 \text{ in. lbs.}$$

$$\text{Total bending moment} = 656,100 \text{ in. lbs.}$$

$$\text{Maximum live load end shear per rail} = 50,000 \#$$

$$\text{Impact per rail} = 50,000 \frac{300}{315} = 47,700 \#$$

$$\text{Dead load shear per foot of width} = 2920 \#$$

In the following discussion the following symbols will be used.

$M_1$  = Live load bending moment per rail

$I$  = Impact " " " "

$M_d$  = Dead load " " " "

$R_1$  = Live load shear " "

$I_s$  = Impact " "

$R_d$  = Dead load " "

$M$  = Total bending moment

$S$  = Total Shear

$M_1'$ ,  $I'$ ,  $M_d'$ ,  $R_1'$ ,  $I_s'$  and  $R_d'$ , refer to the same stresses per foot of width.

$$\text{B.-16ft. SPAN:- } M_1 = 2,100,000 \text{ in lbs.}$$

$$I = 2,000,000 \text{ in lbs.}$$

$$M_1' = 500,000 \text{ in lbs.}$$

$$I' = 285,700 \text{ in lbs.}$$

$$M_p' = \frac{390 \times 16^2 \times 12}{8} = 150,000 \text{ in. lbs.}$$

$$M' = 725,700 \text{ in. lbs.}$$

$$R_1 = 53,100 \#$$

$$R_1' = 7,590 \#$$

$$I_s' = 7,200 \#$$

$$R_d' = 390 \times 8 = 3,120 \#$$

$$S' = R_d' + I_s' + R_1' = 17,910 \#$$



C.--17ft. SPAN:-  $M_1 = 2,320,000$  in. lbs.

$M_1' = 391,400$  In. lbs.

$I' = 313,500$  in. lbs.

$M_d' = 169,000$  in. lbs.

$M' = 813,900$  in Lbs.

$R_1 = 55,900 \#$

$R_1' = 8,000 \#$

$I_s' = 7,570 \#$

$R_d' = 3,310 \#$

$S' = 18,880 \#$

D.--22ft. SPAN:- Assume thickness of slab of 2ft. 8 in.

$M_1 = 3,690,000$  in Lbs.

$M_1' = 527,150$  in. lbs.

$I' = 492,000$  in. lbs.

$M_d' = 356,000$  in. lbs.

$M' = 1,375,150$  in. lbs.

$R_1 = 66,000 \#$

$R_1' = 9,450 \#$

$I_s' = 8,800 \#$

$R_d' = 5,390 \#$

$S' = 23,620 \#$

#### DESIGN OF SLABS

In all the following work the symbols used by Turneaure and Maurer are used.

$$n=15$$

$$f_s = 15000 \#$$

$$f_c = 750 \#$$

$$\frac{f_s}{n f_c} = \frac{1-k}{i}$$



$$\frac{15000}{15 \times 750} = \frac{1-k}{k} = 1.335$$

$$K = .428$$

$$J = 1 - 1/3k = .857$$

$$M_s = F_s \text{ Adj}$$

$$A = \frac{M_s}{F_s \text{ jd}}$$

$$Mc = 1/2 F_c K j \text{ bd}^2$$

$$F_c = \frac{2Mc}{K j \text{ bd}^2}$$

A.--15ft. SLAB:--D.--23-2 1/2=20 1/2 in.

$$M=656,100 \text{ in. lbs.}$$

$$A = \frac{656,100}{15000 \times .857 \times 20.5} = 2.50 \text{ sq. in.}$$

$$F_c = \frac{2 \times 656,100}{.428 \times .857 \times 12 \times 20.5^2} = 708 \#$$

Use 7/8 sq. in. bars spaced 3 1/2" centers.

B.--16ft. SLAB:--D.--24-2 1/2=21 1/2 in.

$$M=735,700 \text{ in. lbs.}$$

$$A = \frac{735,700}{15000 \times .857 \times 21.5} = 2.66$$

$$F_c = \frac{2 \times 735,700}{.428 \times .857 \times 12 \times 21.5^2} = 722 \#$$

Use 7/8 in. sq. bars at 3 1/2 in. centers.

C.--17ft. SLAB:--D. =25-2 1/2=22 1/2 in.

$$M=813,900 \text{ in. lbs.}$$

$$A = \frac{813,900}{15000 \times .857 \times 22.5} = 2.82 \text{ sq. in.}$$

$$F_c = \frac{2 \times 813,900}{.428 \times .857 \times 12 \times 22.5^2} = 729 \#$$

Use 7/8 in. sq. at 3" centers.





D.--22ft. SLAB:- D=32-3=29 in.

$$M=1,375,150 \text{ in. lbs.}$$

$$A=\frac{1,375,150}{15000 \times .857 \times 29} = 3.70 \text{ sq. in.}$$

$$F_c = \frac{2 \times 1,375,150}{.428 \times 857 \times 12 \times 29} = 742 \#$$

Use 1 in. round bars at 2 1/2 in. centers.

The following diagrams show where rods should be turned up to resist shear. No stirrups are needed.

#### LIFTING STIRRUPS

$$\text{Weight of 22 foot slab} = \frac{32}{12} \times 7 \times 22 \times 150 = 61,700 \#$$

$$\frac{61,700}{15000} = 4.1 \text{ sq. in. } \text{-- area of stirrup.}$$

Use 2 stirrups 1 5/8 in. round.

$$\text{Weight of 1-17 foot slab} = \frac{25}{12} \times 7 \times 17 \times 150 = 37,300$$

$$\frac{37,300}{15,000} = 2.49 \text{ sq. in.}$$

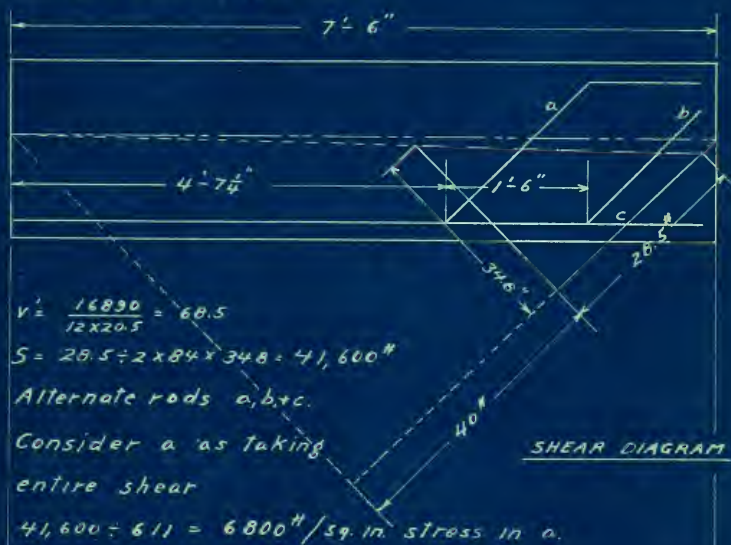
Use 2 stirrups 1 1/2 in. round.



## 15'-0" SLAB

WIDTH 7'-0" DEPTH 23" DEPTH TO STEEL 20 $\frac{1}{2}$ "

STEEL  $\frac{3}{8}$ "  $\square$  BARS  $3\frac{1}{2}$ " C.T.O.C.

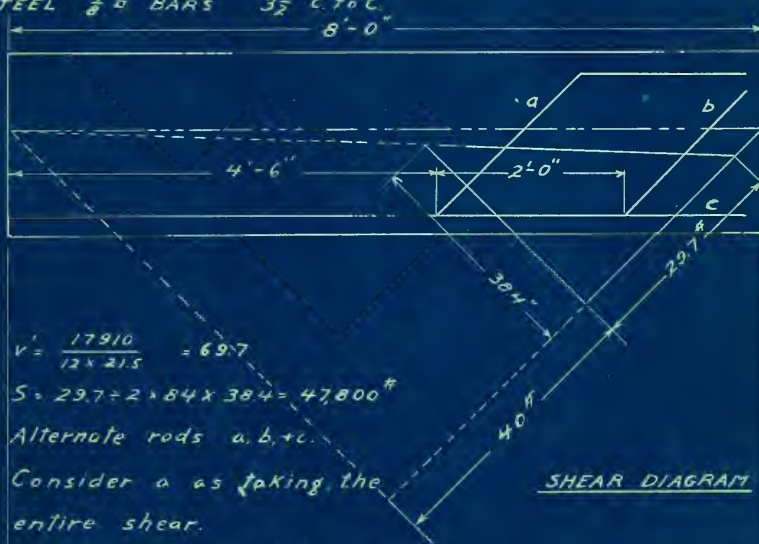




# 16'-0" SLAB

WIDTH 7'-0" DEPTH 24" DEPTH TO STEEL 21 1/2"

STEEL 3/8" BARS 3 1/2" C.T.O.C.  
8'-0"



$$V = \frac{17910}{12 \times 21.5} = 69.7$$

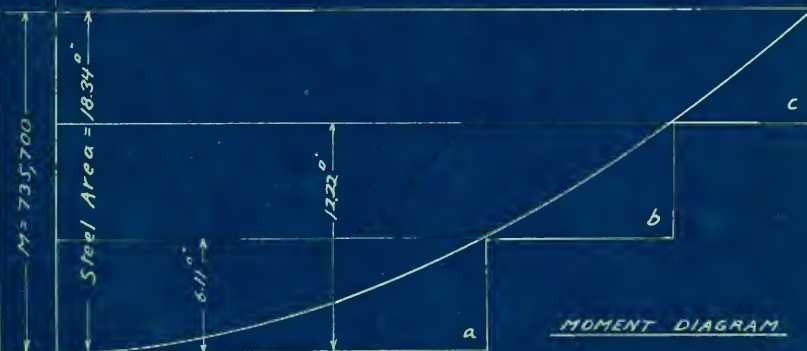
$$S = 29.7 \div 2 \times 84 \times 384 = 47,800 \text{ in}^3$$

Alternate rods a, b, + c.

Consider a as taking the entire shear.

SHEAR DIAGRAM

$$47,800 \div 6.11 = 7850 \text{ lb/sq in. stress in a.}$$



MOMENT DIAGRAM

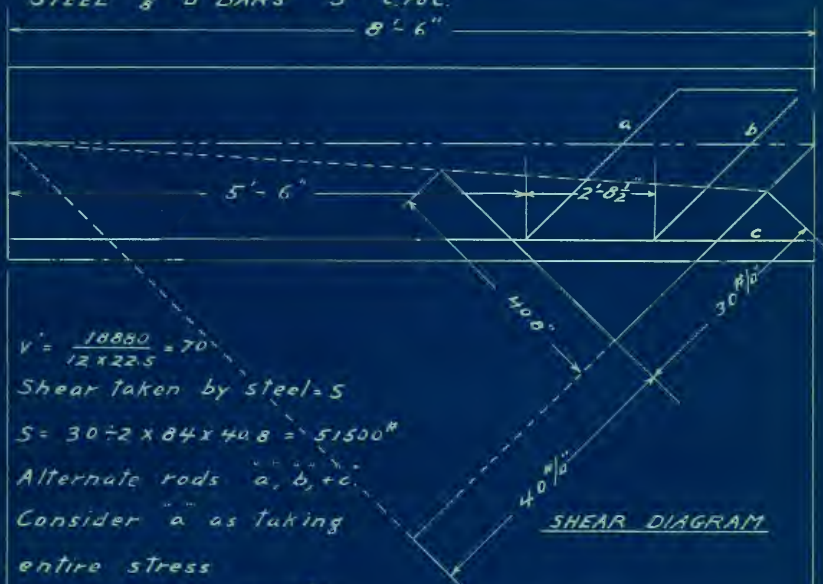


## 17'-0" SLAB

WIDTH 7'-0" DEPTH 25" DEPTH TO STEEL 22½"

STEEL ¾" Ø BARS 3" C76C.

8'-6"



$$V = \frac{18880}{12 \times 22.5} = 70$$

Shear taken by steel = S

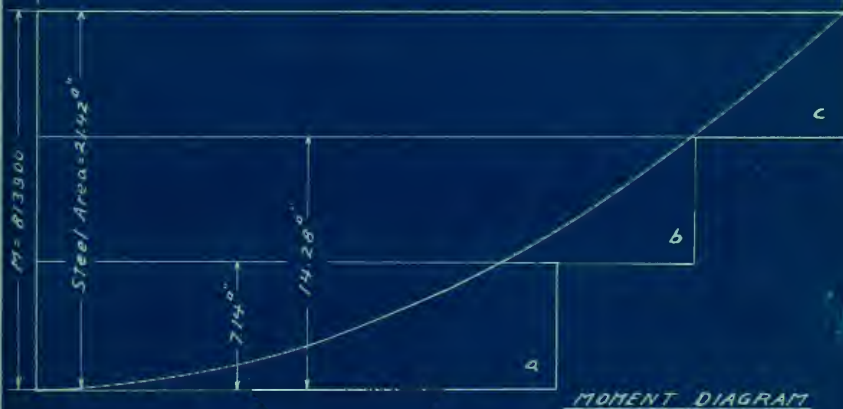
$$S = 30 \div 2 \times 84 \times 40.8 = 51500^M$$

Alternate rods a, b, + c.

Consider "a" as taking

entire stress

$$51,500 \div 7.14 = 7230^M / \text{sq. in. stress in a.}$$

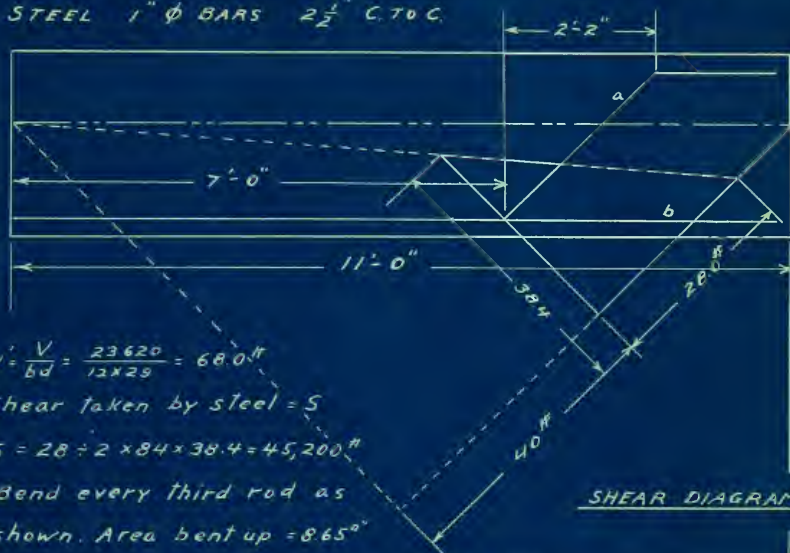






## 22'-0" SLAB

WIDTH 7'-0" DEPTH 32" DEPTH TO STEEL 29"  
STEEL 1"  $\phi$  BARS 2  $\frac{1}{2}$ " C.T.O.C.



$$V = \frac{V}{bd} = \frac{23620}{12 \times 29} = 68.0 \text{ psi}$$

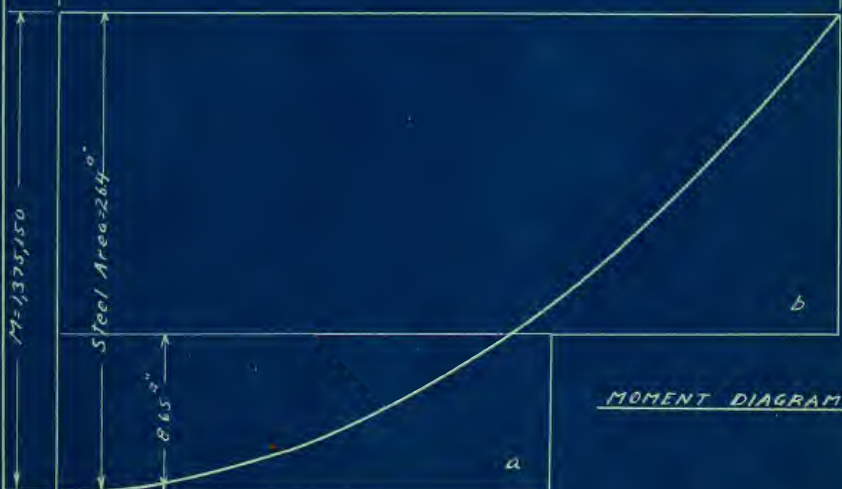
Shear taken by steel =  $S$

$$S = 28 \div 2 \times 84 \times 38.4 = 45,200 \text{ in}^2$$

Bend every third rod as shown. Area bent up = 8.65'

$$45,200 \div 8.65 = 5,230 \text{ psi in stress in steel}$$

SHEAR DIAGRAM



MOMENT DIAGRAM



## DESIGN OF PILE BENT

The maximum live load reaction at any bent supporting two 17 foot slabs is 147,200#. The dead load reaction =  $390 \times 17 \times 14 = 92,500\#$  The total reaction =  $147,200 + 92,500 = 239,700\#$  While this is the reaction for seventeen foot spans it will be used in designing the bents for all spans.

In the absence of any knowledge of the soil conditions at the trestle a pile will be considered as carrying a load of only twenty tons. This value is low enough to allow for the most unfavorable conditions.

$$239,700 \div 46,000 = 5.99$$

Therefore 6 piles will be used in each bent, each one fourteen inches square.

Area of pile = 196 sq. in.

$\frac{40,000}{196} = 204\#$  per sq. in. compression on pile. This value is well within the required limit.

In designing the pile cap we will assume that one pile has settled or failed, causing the cap to act as a continuous beam over a span of four feet six inches (see blue print)

Live load reaction = 147,200#

Dead " " = 92,500#

Total " " = 239,700#

Reaction per foot = 17,100#

Weight of cap per foot = 1,000#

Total weight " " = 18,100#

$$M = w \frac{l^3}{12} = \frac{18100 \times 54^3}{12} = 4,440,000 \text{ in. lbs.}$$



$$K=.428$$

$$j=.857$$

$$d=31 \text{ in.}$$

$$A = \frac{4,440,000}{15000 \times .857 \times 31} = 11.00 \text{ sq. in.}$$

$$F_c = \frac{2 \times 4,440,000}{15000 \times .857 \times 28 \times 31^2} = 890 \#$$

This stress must be reduced to 750 $\frac{\#}{\text{sq. in.}}$  by using compressive steel.

$$\text{Area of tensile steel} = 1.30 \#$$

$$\text{Allowed concrete stress} = 750 \frac{\#}{\text{sq. in.}}$$

$$\text{Per cent reduction} = \frac{890 - 750}{890} = 15.8 \%$$

From table 12 Turneaure and Maurer we find that .52% of compressive steel is needed to cause the reduction.

$$.0052 \times 28 \times 31 = 4.53 \text{ sq. in.}$$

Use 9--1 in. square bars in bottom of cap

Use 5--1 in. " " at top " "

$$\text{Maximum shear} = 18,100 \times 2.25 = 40,700 \frac{\text{lb}}{\text{sq. in.}}$$

$$\frac{40,700}{28 \times 31} = 47.0 \frac{\text{lb}}{\text{sq. in.}} \text{ shear}$$

Since this value is within the allowed value for concrete, no steel is needed to resist the shear.

Double pile caps will be used for every fifth bent. About 1 1/2 times as much steel will be used as in the other caps.



## DESIGN OF PIER

When the distance from base of rail to the ground exceeds sixteen feet, thin piers will be used instead of pile bents. For slabs with a twenty-two foot span, piers will be used in all cases. The pier will be designed for a twenty two foot span and the same section used for all other spans. The stresses that the pier must resist consist of direct compression, due to the weight of the structure and load, and bending moment, due to the stopping of a train on the trestle. The use of an expansion joint at each pier eliminates bending due to the expansion and contraction of the slabs, and the fact that thin piers are used reduces the wind and current stresses to a negligible quantity.

Weight of 22ft. span = 116,500#

" " pier about 67,000#

Maximum pier reaction = 175,400#

Total load on pier = 358,900#

Pier cross section = 24 in. x 168 in.

$358,900 \div 40,000 = 9$  piles needed.

$358,900 \div (24 \times 169) = 130\frac{1}{2}$  compression.

Maximum load in one panel due to uniform train load =

$22 \times 5000 = 110,000\frac{1}{2}$

Force acting at top of rail due to stopping of train =

$1/5 \times 110,000 = 22,000\frac{1}{2}$





Since the height of pier varies we will assume an extreme case in designing the steel to resist bending. Assume a height of twenty feet to rail top.

$$M = 22000 \times 20 \times 12 = 5,270,000 \text{ in. lbs.}$$

$$A = \frac{5,270,000}{15000 \times .857 \times 21} = 19.5 \text{ sq. in.}$$

$$F_c = \frac{2 \times 5,270,000}{.428 \times .857 \times 14 \times 12 \times 21} = 384 \frac{1}{2}$$

Use 20 one inch square bars spaced uniformly across the pier.

#### PIER FOOTING

Assume a depth of footing of 42 inches and a depth to steel of 32 inches.

Area of section resisting shears=

$$2 \times 32 \times 168 = 10,740 \text{ sq. in.}$$

$$358,900 \div 10740 = 33.4 \frac{1}{2} \text{ per sq. in.}$$

$$M = \frac{358,900}{2} \times 18 = 3,230,000 \text{ in. lbs.}$$

$$A = \frac{3,230,000}{15000 \times .857 \times 32} = 7.65 \text{ sq. in.}$$

Use 14-3/4 in. square bars.

$$F_c = \frac{2 \times 3,230,000}{.428 \times .857 \times 14 \times 12 \times 32} = 103 \frac{1}{2}$$



## DESIGN OF ABUTMENT

The abutment shown on plate 1 will be used in all cases. We will consider a surcharge of five feet and figure the earth pressure at the various depths. The stability of the abutment is determined on plate 1 using the following figures for earth pressures and weights.

$$p = .5 \times 120 \times 15.33 = 588 \#$$

$$p = .3 \times 120 \times 8.80 = 317 \#$$

$$P = \frac{517 + 588}{2} \times 12.5 = 5000 \#$$

This pressure P acts at a distance of 11 feet from the bottom of the footing.

$$\text{Wt. of 1 ft. of front wall} = 5840 \#$$

$$\text{" " " " " earth A} = 3080 \#$$

$$\text{" " 2 side walls} = 45000 \#$$

$$\text{" " 2 " " " per ft.} =$$

$$\text{of abutment face} = 3220 \#$$

$$\text{Dead load reaction from 15 ft slab} = 2900 \#$$

All these forces are shown acting at their respective points of application in plate 1. They are combined graphically and the resultant R is found to fall within the middle third.

$$\text{The vertical component of this resultant is } 14720 \#$$

$$\text{Total dead load on abutment} = 14720 \times 14 = 206,000 \#$$

$$\text{Live load reaction} = 132,000 \#$$

$$\text{Total load on abutment piles} = 338,000 \#$$

$$338,000 \div 40,000 = 10 \text{ nearly.}$$

Use 10 piles in abutment.



Consider part of side walls to left of lines BB (see diagram.) to be supported by the diaphragm.

$$\text{Pressure at top} = .3 \times 120 \times 5 = 180 \#$$

$$\text{" " bottom} = .3 \times 120 \times 17.8 = 642 \#$$

$$\text{Total pressure} = \frac{180 + 642}{2} (6 \times 6.75 \frac{6 \times 6}{2}) = 240000 \#$$

$$\text{Total tension taken by steel} = 48000 \#$$

$$48000 + 15000 = 3.20 \text{ sq. in. needed.}$$

Use 14-1/2 in. rods.

Consider the part of wall between the diaphragm and the front wall to act as a simple resisting horizontal earth pressures. At the bottom the pressure per square foot is 216 #

$$\frac{M = w l^2}{8} = \frac{216 \times 8^2 \times 12}{8} = 20,700 \text{ in. lbs.}$$

$$d = 18 - 3 = 15 \text{ in.}$$

$$A = \frac{20700}{15000 \times .857 \times 15} = .107 \text{ sq. in. per ft.}$$

$$F_c = \frac{2 \times 20700}{.428 \times .857 \times 12 \times 15} = 417 \#$$

Use 1/2" square bars at 10 inch centers.

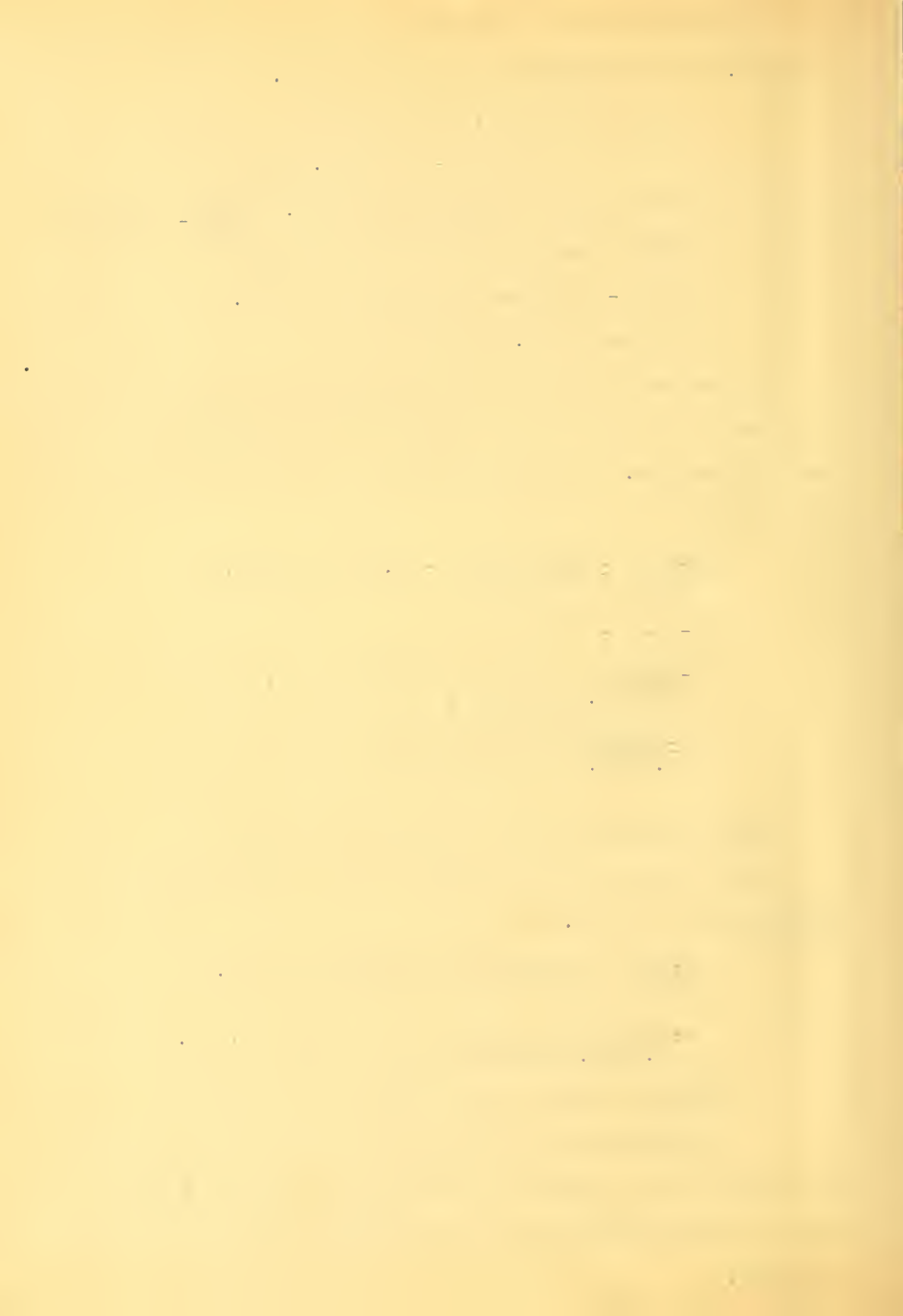
The pressure at the bottom of the front wall is 432 # per square foot.

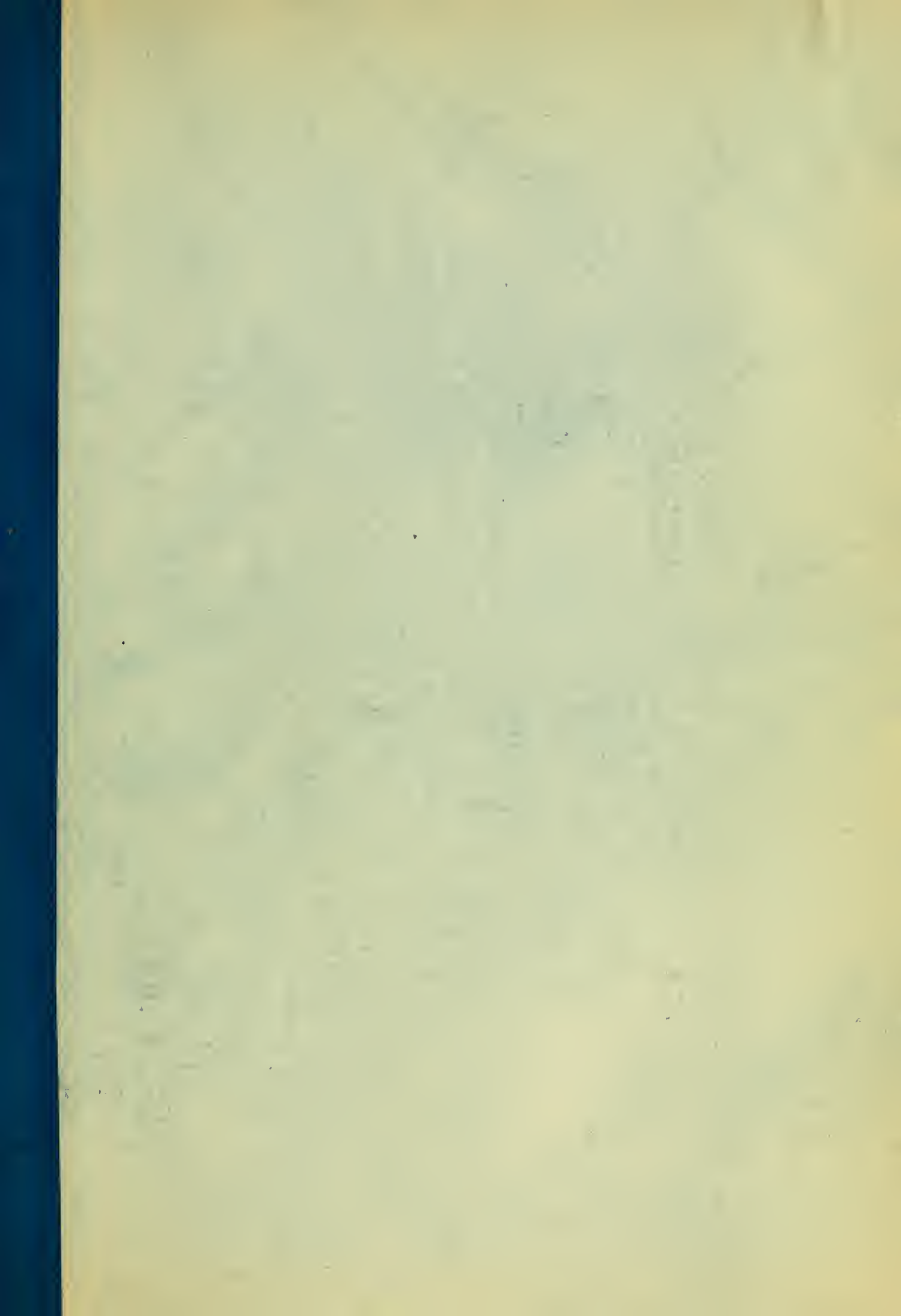
$$\frac{M = w l^2}{8} = \frac{432 \times 14^2 \times 12}{8} = 127000 \text{ in. lbs.}$$

$$A = \frac{2 \times 127000}{.428 \times .857 \times 12 \times 21} = 131 \# \text{ per sq. in.}$$

Use 3/4" square bars at 14 inch centers.

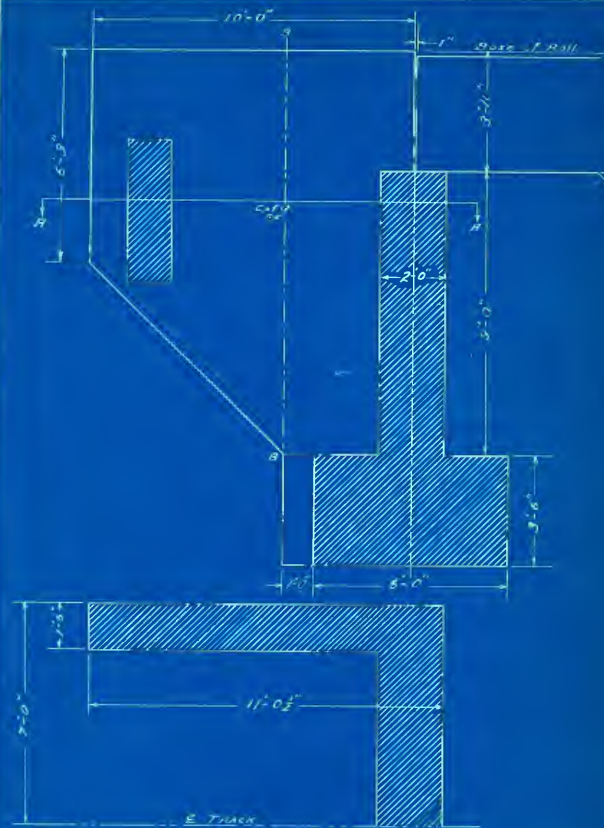
In addition to the steel figured above other rods are used for the purpose of holding the reinforcement in place as well as to take care of smaller and less important stresses.



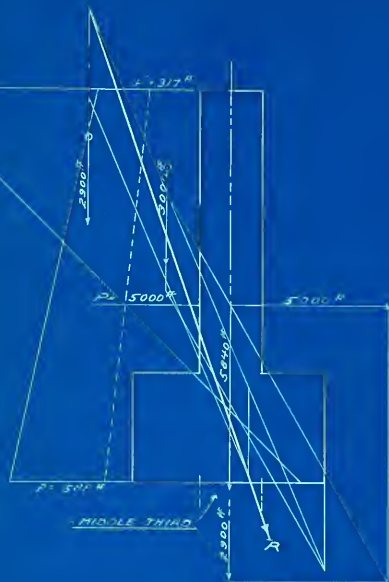








SECTION BB



DESIGN OF A STANDARD  
REINFORCED CONCRETE  
RAILWAY TRESTLE

ABUTMENTS

PLATE I. SCALE  $1"=3'$   
MAY 11/1912 T.F. WOLFE



8'-0"

3'-11  $\frac{3}{4}$ "

Drain  
2" Dia







A hand-drawn diagram on a grid background, showing a rectangular layout with dimensions and annotations. The top horizontal dimension is divided into segments:  $4'-11\frac{1}{2}"$ ,  $4'-0"$ ,  $4'-0"$ , and  $4'-11\frac{1}{2}"$ . The bottom horizontal dimension is divided into segments:  $2'-11\frac{1}{2}"$ ,  $4'-0"$ ,  $4'-0"$ ,  $4'-0"$ , and  $2'-11\frac{1}{2}"$ . The total width is labeled  $21'-11\frac{1}{2}"$  at the bottom center. The vertical dimension is divided into segments:  $4'-0"$ ,  $4'-0"$ , and  $4'-0"$ . Annotations include "Bend here" with an arrow pointing to a vertical line, and "Bend here" with an arrow pointing to a horizontal line. There are also circular symbols on the grid, one on the left and one on the right, each with a dashed circle around it.

14'-0"

9 Spaces @ 1'-0" = 10'-0"

2'-1 1/2"

17'-8"

Drain holes 2nd

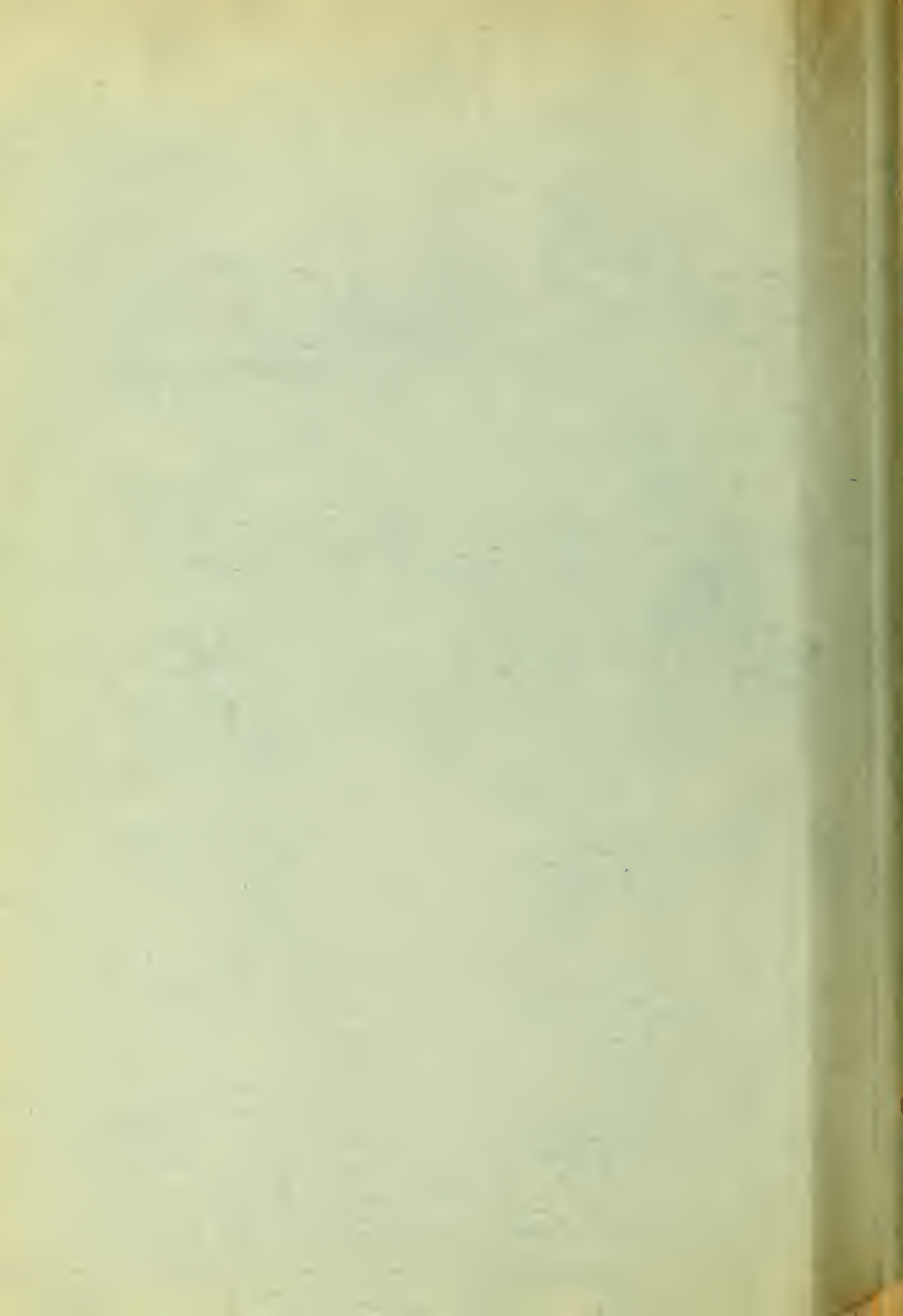
Bend up alternate ends

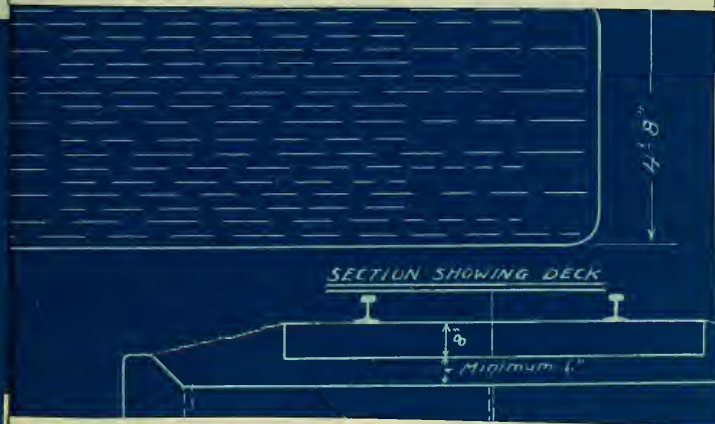
Elevation of bar. All bars alike.

Hand-drawn reinforcement layout for a rectangular slab. The drawing shows a grid of reinforcement bars with dimensions and labels. Key dimensions include: overall width 3'-4", overall length 4'-6", and a central section of 2'-0" by 2'-0". Reinforcement bars are labeled as 1/2" dia. and 3/8" dia. A note indicates "Bars 1/2" dia. x 6'-0" 2'-0" circs". A curved arrow indicates a "Bend here" for a bar. The drawing is on a grid background.

[illegible][illegible]

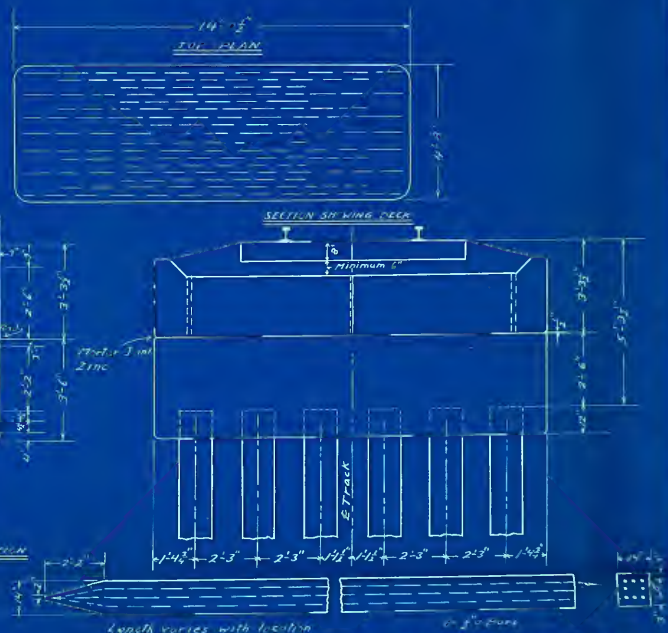
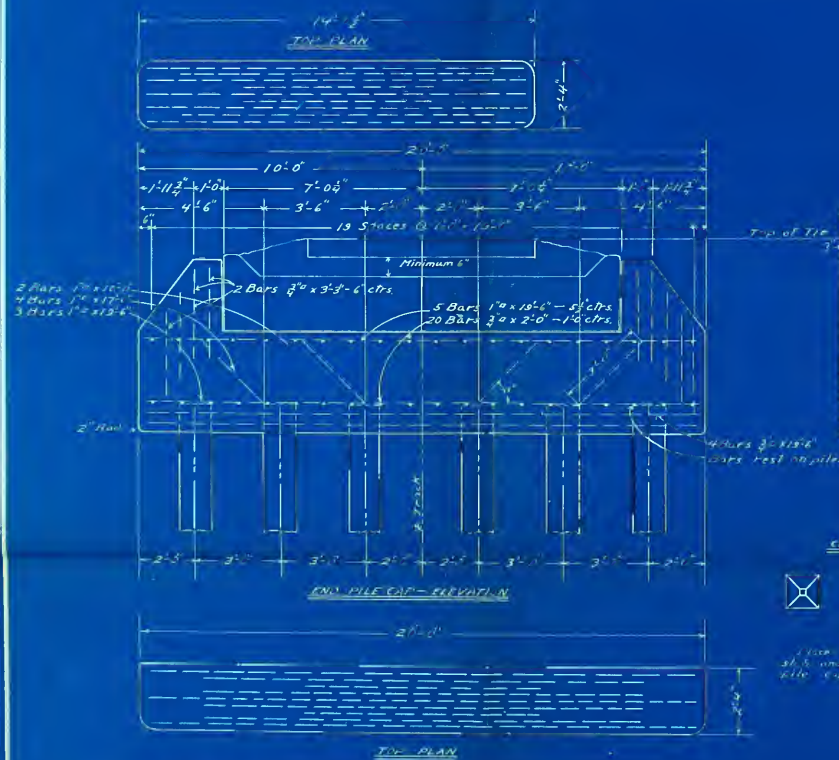
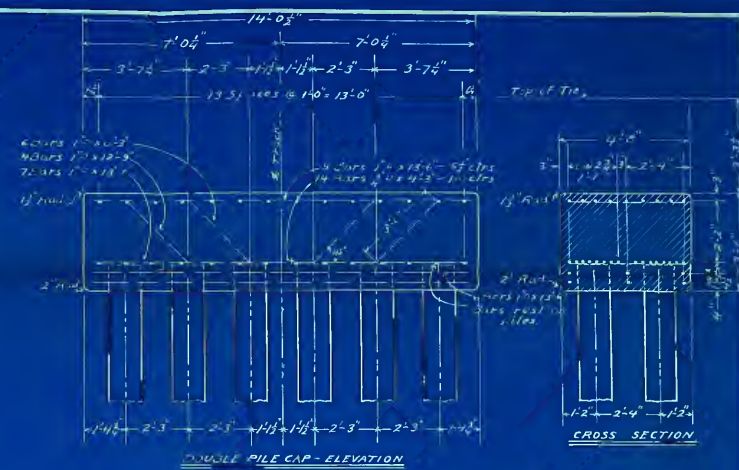
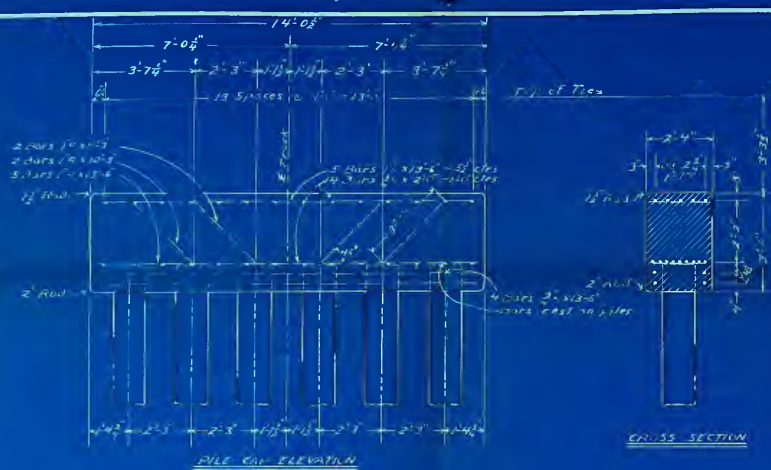
DESIGN OF A STANDARD  
REINFORCED CONCRETE  
RAILWAY TRESTLE  
SLABS  
PLATE 2 SCALE 1/4" = 1'-0"  
MAY 11, 1910 T. E. WOLFE





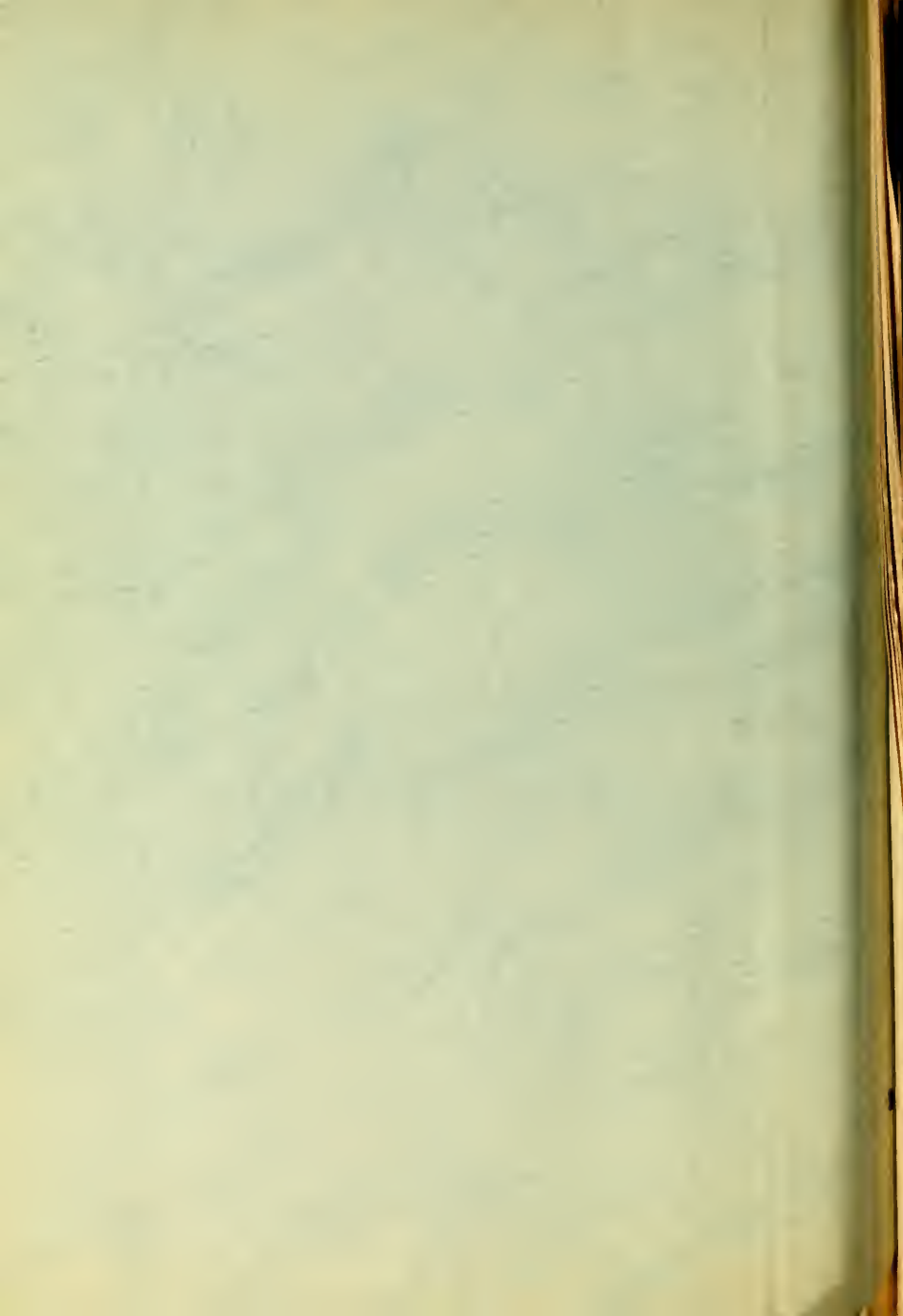






**NOTE**  
 1. SHOWN SHOT LINE BETWEEN  
 2. SHOWN SHOT LINE BETWEEN  
 3. SHOWN SHOT LINE BETWEEN

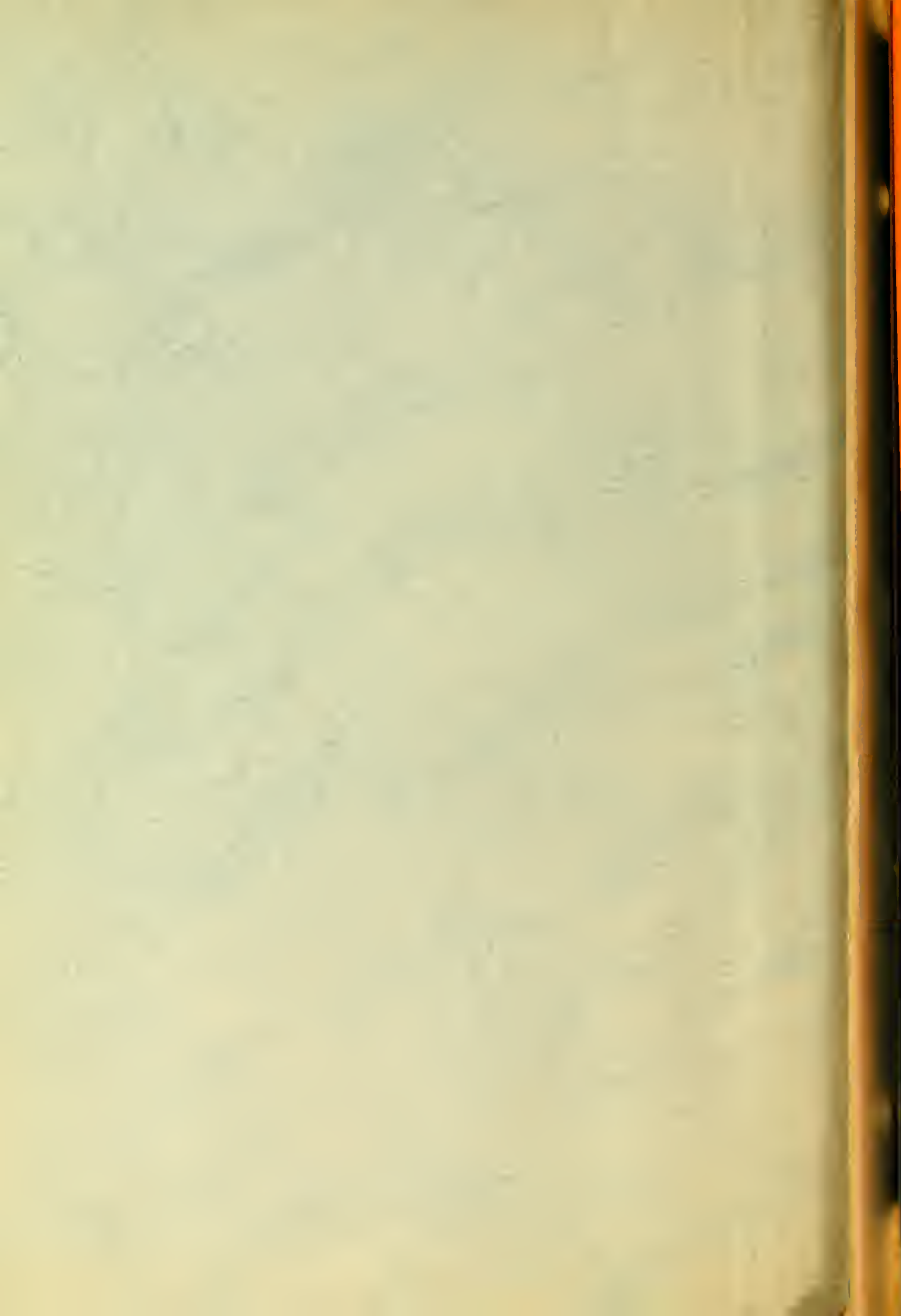
**DESIGN OF A STANDARD  
 REINFORCED CONCRETE  
 RAILWAY TRESTLE**  
 FILE BENTS  
 PLATE 3  
 MAY 1910



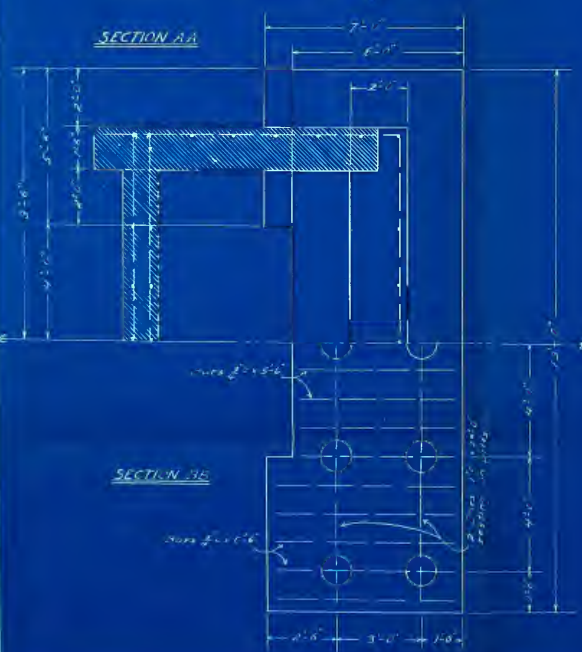
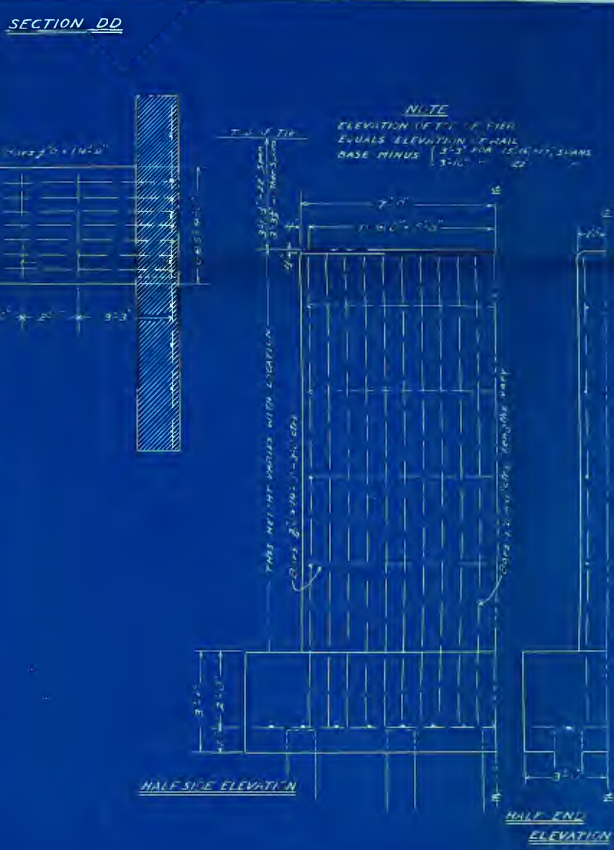
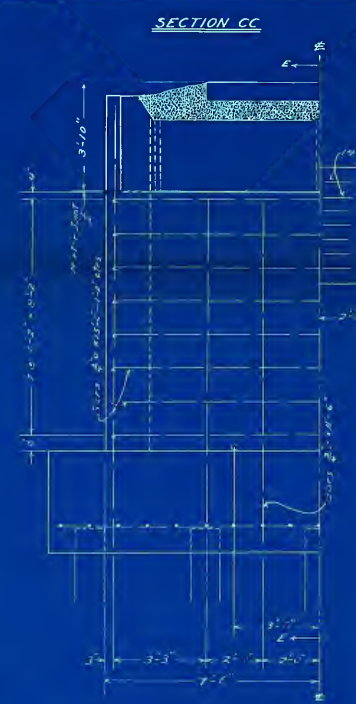
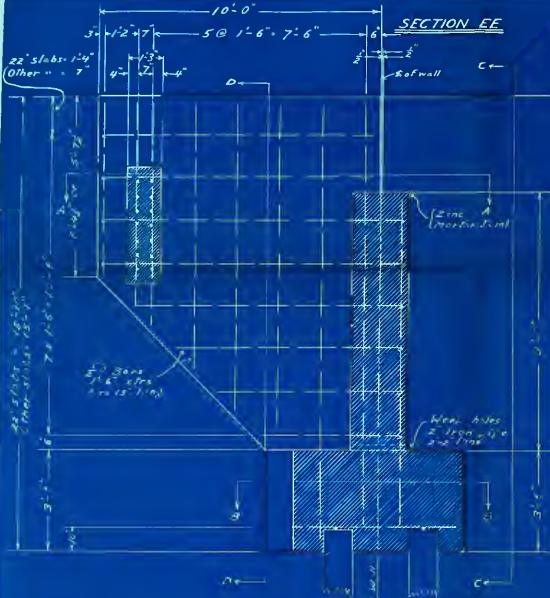
3' 6"

2' 8"

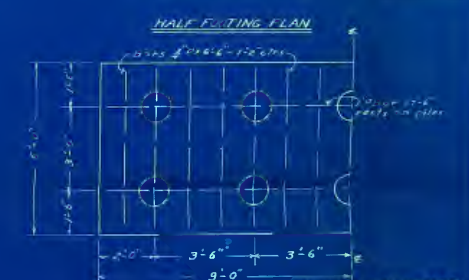
5'



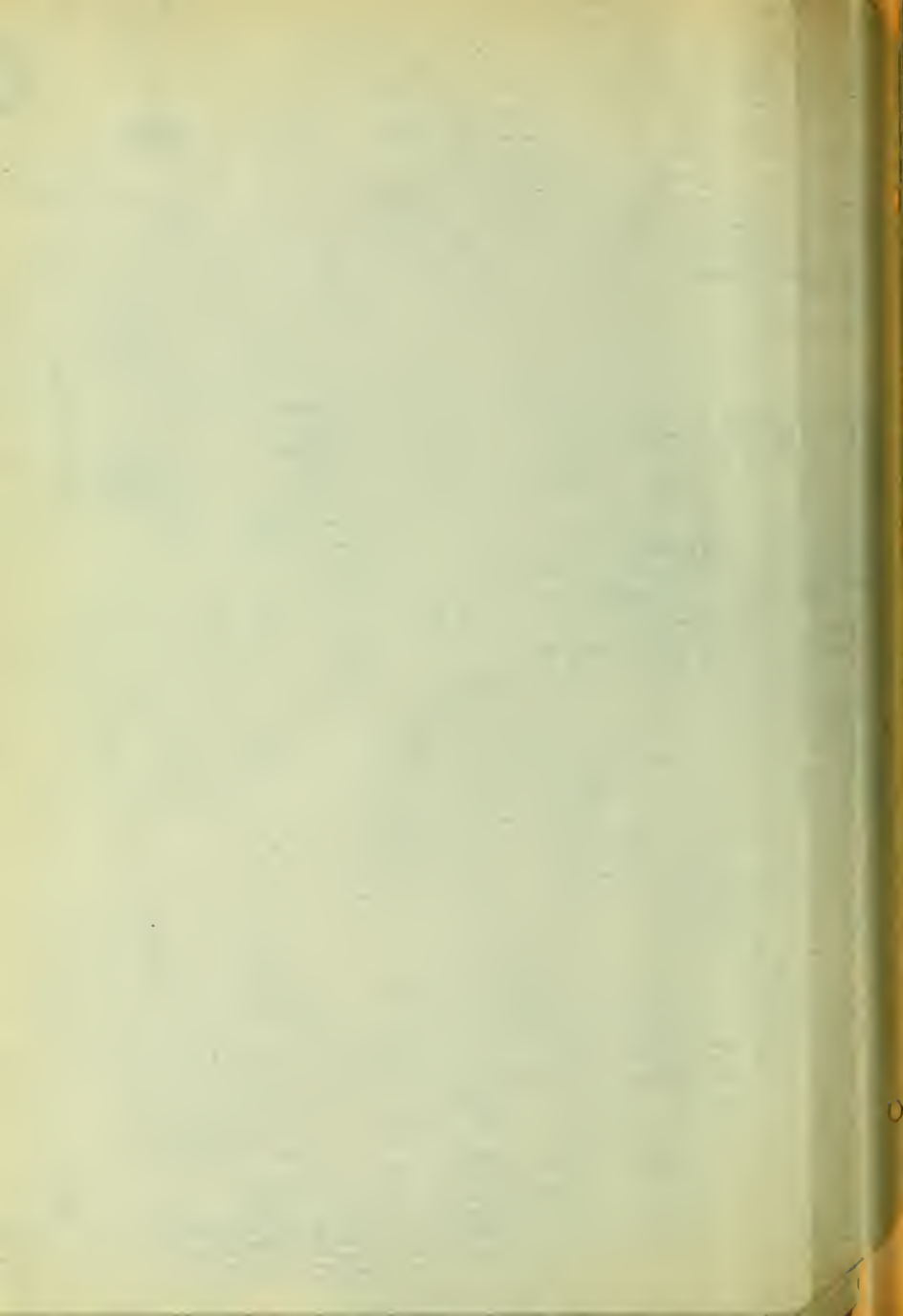




**NOTE**  
IN ALL WALLS, HORIZONTAL STEEL  
IS 3" PILING, TYPICAL FACE.  
HORIZ. ENDS OF P. IS AS SHOWN.  
WIRE BARS TOGETHER AT INTERSECTIONS  
SHIRT ZING TO BE PLACED BETWEEN STEEL  
AND HORIZONTAL ZING IN ADJUTMENT.



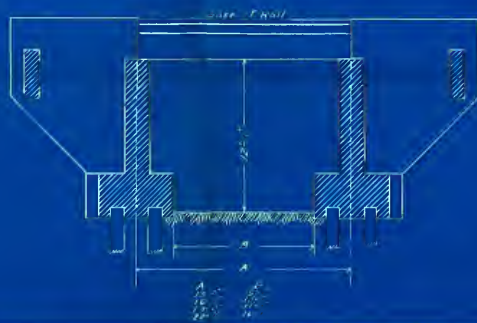
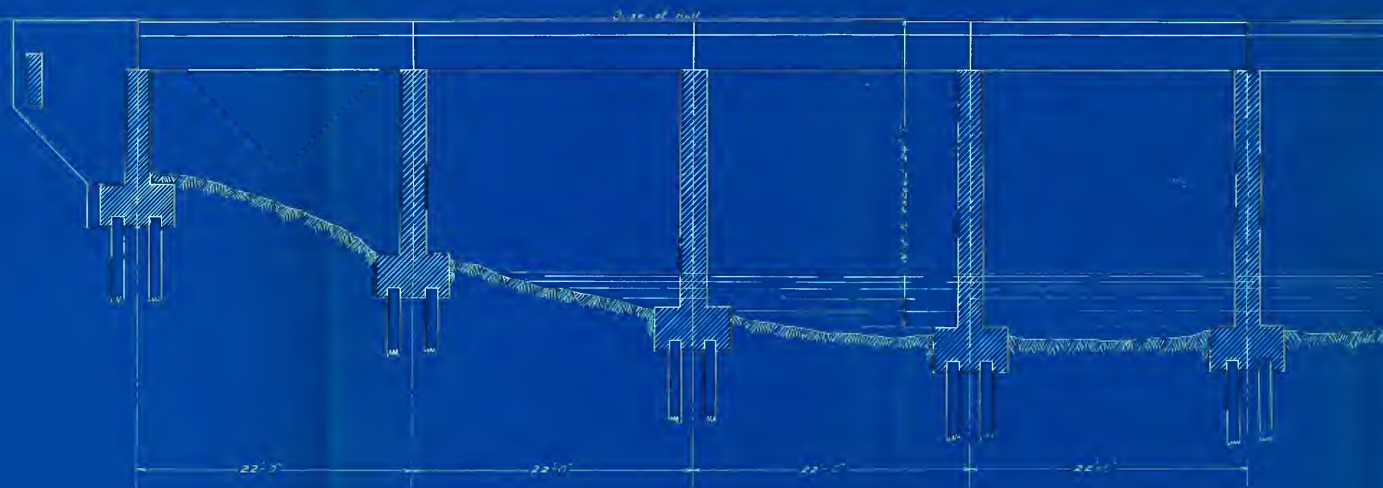
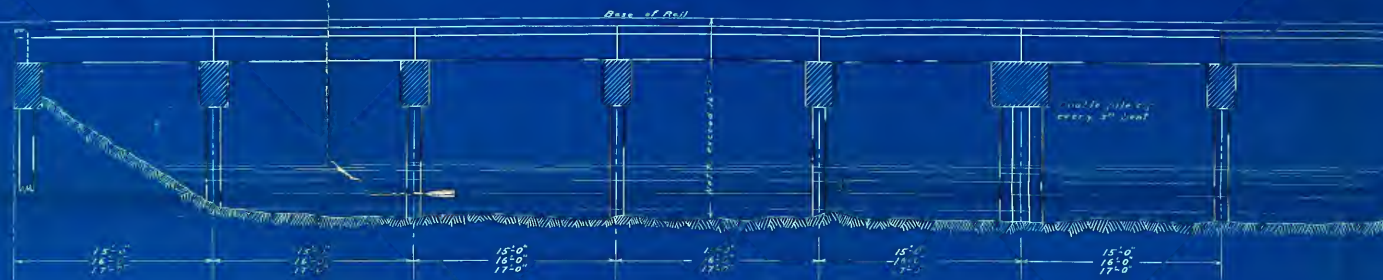
**DESIGN OF A STANDARD  
REINFORCED CONCRETE  
RAILWAY TRESTLE**  
ABUTMENT - PIER  
PLATE #1  
SCALE 1/4" = 1'-0"  
MAY 1912



Not to exceed 24' 0"







NOTE

USE PILE TRESTLE WHERE DISTANCE FROM BASE OF RAIL TO GROUND LEVEL EXCEEDS 16 FT.

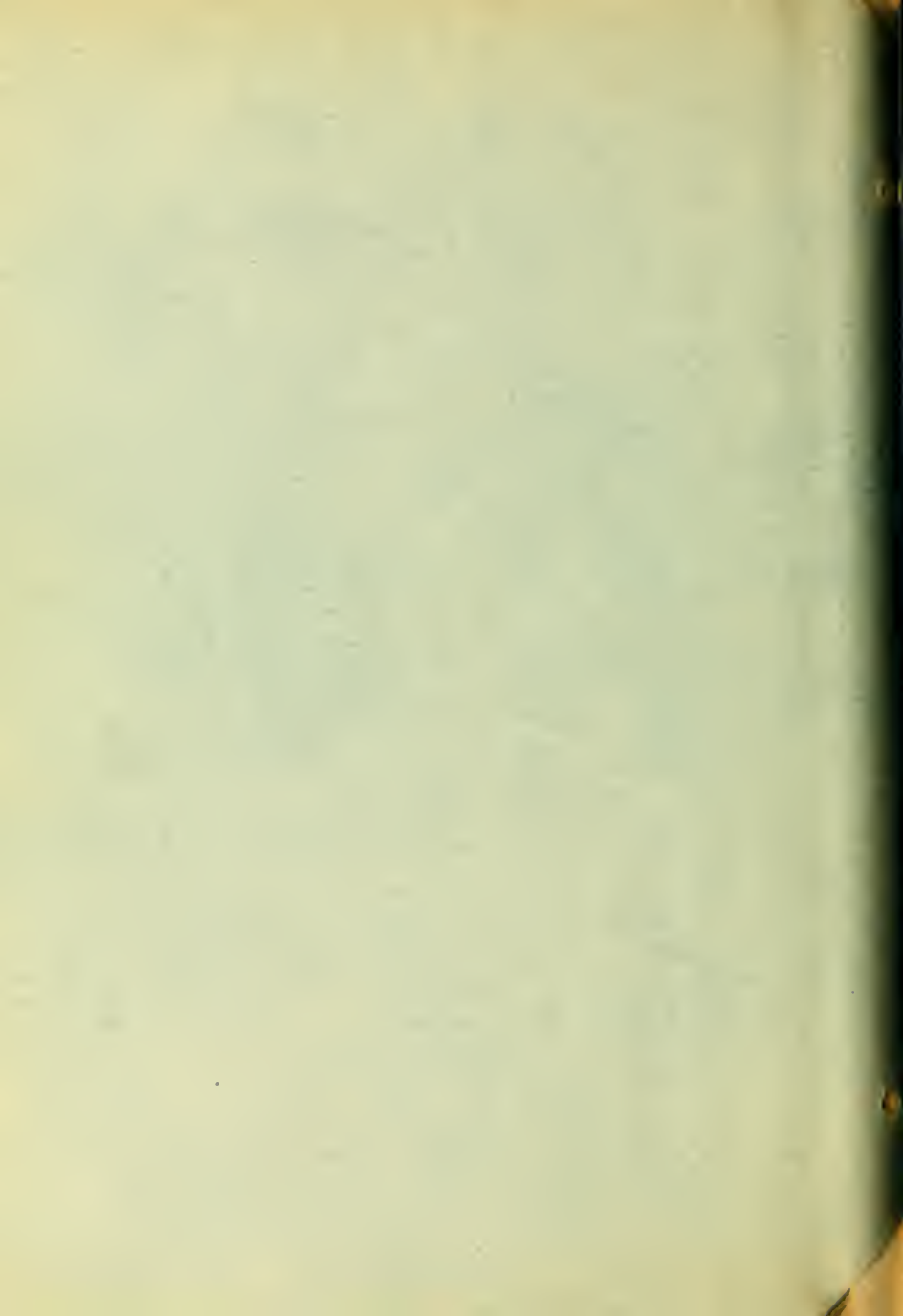
USE THIN PIER TRESTLE FOR HEIGHTS BETWEEN 16 FT AND 24 FT.

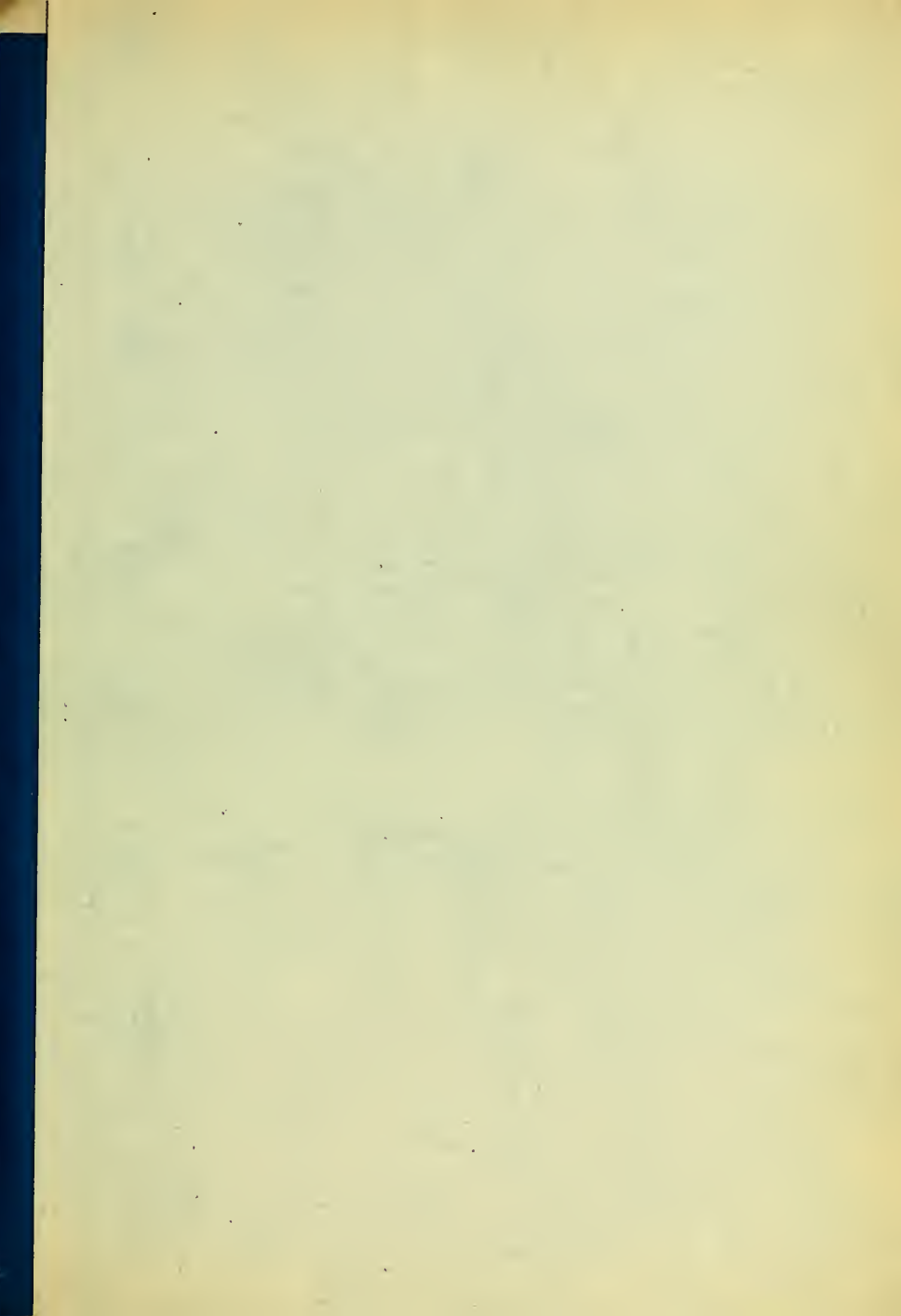
FOR COUNTRY HIGHWAY UNDERPASS CROSSINGS, CATTLE GATES ETC. USE ARRANGEMENT SHOWN TO LEFT.

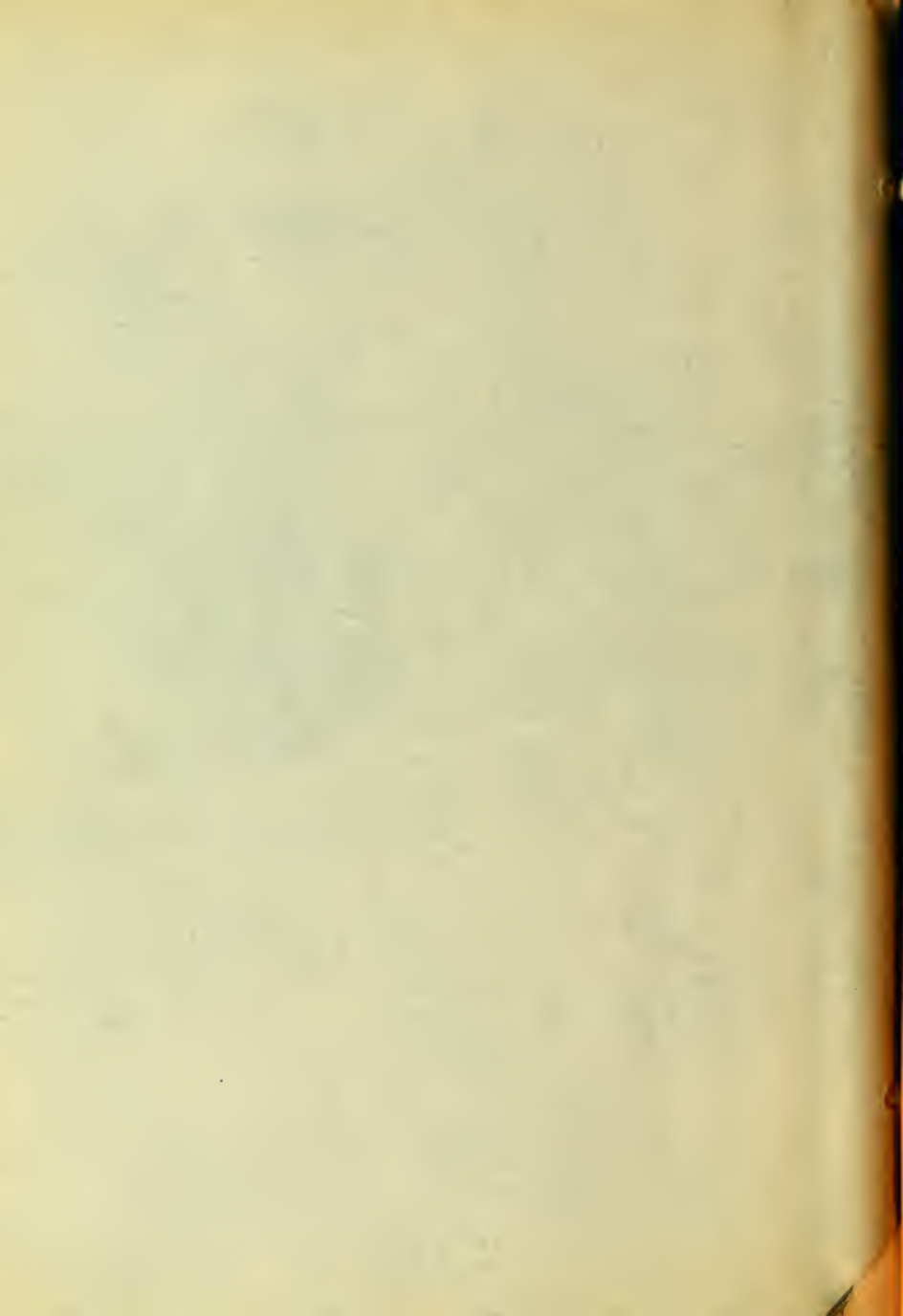
ALL VIEWS SHOWN ARE SECTIONS ALONG CENTER LINES.

DESIGN OF A STANDARD  
REINFORCED CONCRETE  
RAILWAY TRESTLE  
TYPES

PLATE 5 SCALE 1/4" = 1'-0"  
MAY 11 1912 T. F. WOLFE







1 ABUTMENT			
NO.	SIZE	LENGTH	LOCATION
2		6'-0"	VERTICAL IN SIDE WALLS
2		7'-0"	
2		7'-9"	
2		9'-3"	
2		10'-9"	
2		11'-6"	HORIZONTAL IN SIDE WALLS
8		15'-3"	
6		9'-6"	
4		11'-0"	
2		10'-0"	
2		8'-9"	FRONT-HORIZONTAL
2		8'-0"	
2		5'-3"	
8	$\frac{3}{4}$ "	15'-0"	
5	$\frac{3}{4}$ "	11'-6"	
14	$\frac{1}{2}$ "	14'-9"	DIAPHRAM
10	$\frac{3}{4}$ "	3'-6"	"
10	$\frac{3}{4}$ "	6'-6"	FOOTING
9	$\frac{3}{4}$ "	5'-6"	"
2	1"	18'-6"	"
39.22 YDS. OF CONCRETE			
1,217 LBS. STEEL BARS			

1 PIER			
NO.	SIZE	LENGTH	LOCATION
15	$\frac{3}{4}$ "	6'-6"	FOOTING
2	1"	17'-6"	"
8	$\frac{3}{4}$ "	14'-0"	HORIZONTAL IN PIER
42	1"	VARIES	VERTICAL " "
CU. YDS. CONCRETE = $13.6 + 1.04L$			
LBS. STEEL = $519 + 142.5L$			
WHERE L = DISTANCE FROM TOP OF FOOTING TO TOP OF PIER.			

1 PILE CAP			
NO.	SIZE	LENGTH	LOCATION
5	1"	13'-6"	TOP
5	1"	13'-6"	BOTTOM
2	1"	8'-3"	" BENT
2	1"	12'-9"	" "
4	$\frac{3}{4}$ "	13'-6"	"
14	$\frac{3}{4}$ "	2'-0"	TRANSVERSE
3.92 CU. YDS. CONCRETE			
760 LBS. OF STEEL BARS			

1 DOUBLE PILE CAP			
NO.	SIZE	LENGTH	LOCATION
5	1"	13'-6"	TOP
7	1"	13'-6"	BOTTOM
6	1"	8'-3"	" BENT
4	1"	12'-9"	" "
4	$\frac{3}{4}$ "	13'-6"	"
14	$\frac{3}{4}$ "	4'-3"	TRANSVERSE
7.90 CU. YDS. OF CONCRETE			
1296 LBS. OF STEEL BARS			

1 END PILE CAP			
NO.	SIZE	LENGTH	LOCATION
5	1"	13'-6"	TOP
3	1"	13'-6"	BOTTOM
2	1"	10'-0"	" BENT
4	1"	17'-0"	" "
4	$\frac{3}{4}$ "	13'-6"	"
20	$\frac{3}{4}$ "	2'-0"	TRANSVERSE
8	$\frac{3}{4}$ "	3'-3"	VERTICAL AT ENDS
6.1 CU. YDS. OF CONCRETE			
1172 LBS. STEEL BARS			

1-15' SPAN - 2 SLABS			
NO.	SIZE	LENGTH	LOCATION
16	$\frac{3}{4}$ "	14'-8"	BOTTOM
16	$\frac{3}{4}$ "	15'-9"	" BENT
14	$\frac{3}{4}$ "	15'-0"	" "
14	$\frac{3}{4}$ "	6'-8"	" TRANS.
14	$\frac{3}{4}$ "	3'-0"	SLANT IN PARAPET
4	$\frac{3}{4}$ "	14'-8"	" "
15.5 CU. YDS. OF CONCRETE			
2247 LBS. OF STEEL BARS			

1-16' SPAN - 2 SLABS			
NO.	SIZE	LENGTH	LOCATION
16	$\frac{3}{4}$ "	15'-8"	BOTTOM
16	$\frac{3}{4}$ "	16'-10"	" BENT
14	$\frac{3}{4}$ "	17'-1"	" "
16	$\frac{3}{4}$ "	6'-8"	" TRANS.
16	$\frac{3}{4}$ "	3'-0"	SLANT IN PARAPET
4	$\frac{3}{4}$ "	15'-8"	" "
17.3 CU. YDS. OF CONCRETE			
2280 LBS. OF STEEL BARS			

1-17' SPAN - 2 SLABS			
NO.	SIZE	LENGTH	LOCATION
18	$\frac{3}{4}$ "	16'-8"	BOTTOM
18	$\frac{3}{4}$ "	18'-2"	" BENT
18	$\frac{3}{4}$ "	18'-0"	" "
16	$\frac{3}{4}$ "	6'-8"	" TRANS.
16	$\frac{3}{4}$ "	3'-0"	SLANT IN PARAPET
4	$\frac{3}{4}$ "	16'-8"	" "
19.0 CU. YDS. OF CONCRETE			
2837 LBS. OF STEEL BARS			

1-22' SPAN - 2 SLABS			
NO.	SIZE	LENGTH	LOCATION
56	$\frac{3}{4}$ "	22'-4"	BOTTOM
20	$\frac{3}{4}$ "	6'-8"	" TRANS.
20	$\frac{3}{4}$ "	4'-0"	SLANT IN PARAPET
4	$\frac{3}{4}$ "	21'-6"	IN PARAPET
31.4 CU. YDS. OF CONCRETE			
3540 LBS. OF STEEL BARS			

1 FOOT OF FILE	
.0505 CU. YDS. OF CONCRETE	
6.8 LBS. OF $\frac{1}{2}$ " STEEL BARS	

NOTE  
 CONCRETE IN FOOTINGS TO BE 1:3:5 OR  $1\frac{1}{2}$  BBL'S. CEMENT TO EACH YARD OF CONCRETE.  
 CONCRETE IN ALL OTHER PARTS TO BE 1:2:4 OR 1 $\frac{1}{2}$  BBL'S. OF CEMENT TO EACH YD. OF CONCRETE.

DESIGN OF A STANDARD  
 REINFORCED CONCRETE  
 RAILWAY TRESTLE

SILL OF MATERIAL  
 PLATE 6 SCALE—  
 MAY 12/12 T. F. WOLFE











